Spring 2007 Biology 111 Take-Home Exam #1 KEY - Cellular Communications

There is no time limit on the take-home portion of this exam, though I have tried to design one that you should be able to complete within 2 hours, except for typing. There are 2 pages for this exam, including this cover sheet. You are not allowed to use your notes, old tests, the internet, or any books, nor are you allowed to discuss the test with anyone until the in-class exam is completed at 11:30 am on Monday February 12. **TYPED EXAM ANSWERS ARE DUE AT 10:30 AM ON MONDAY FEBRUARY 12**. You may use a calculator and/or ruler for both portions of the exam. The **answers to the take-home exam must be typed on separate sheets of paper** unless the question specifically says to write the answer in the space provided. If you do not write your answers in the appropriate location, I may not find them.

-3 pts if you do not follow this direction.
Please do not write or type your name on any page other than this cover page.
Staple all your pages (INCLUDING THE TEST PAGES) together when finished with the exam.

Name (please print):

Write out the full pledge and sign:
The following statement is the official Honor Pledge of Davidson College: "On my honor I have neither given nor received unauthorized information regarding this work, I have followed and will continue to observe all regulations regarding it, and I am unaware of any violation of the Honor Code by others."

How long did this exam take you to complete (excluding typing)?

Lab Question:

6 pts.

1) a. Explain in chemical terms why IDH prefers $NADP^+$ over NAD^+.

The extra phosphate in $NADP^+$ provides and extra hydrogen bond which allows $NADP^+$ to bind with greater affinity to IDH than NAD^+ can bind.

b. How would you make 150 mL of a 0.15M solution of NADP+ if the FW = 765.39

Dissolve 17.22 g of $NADP^+$ into water less than 150 mL, then add water to a final volume of 150 mL.

Lecture Questions:

8 pts.

2) a. Can enzymes cause a reaction to happen that cannot happen without the enzyme? Explain your answer.

No, enzymes only catalyze reactions that can happen otherwise. Their intervention speeds up the reaction, but does not create new reactions.

b. What do enzymes do to cause reactions to proceed? 5 sentence maximum.

They lower the energy of activation which is to say they position the reactants very close to each other and often induce a strain to hasten the reaction.

8 pts.

3) Make a table with two columns. In the first column, list all the enzymes in the signal transduction pathway that we discussed that describes how the heart beats harder. In the second column, list how each enzyme becomes activated. Do not write more than one sentence for any of the activations.

Enzyme	**Mechanism of activation**
G protein	Epinephrine receptor activates it when ligand binds
Adenylyl cyclase	G protein
Protein kinase A (PKA)	cAMP
Myosin	Phosphorylated by PKA

8 pts.

4) Draw a picture of how calcium regulates exocytosis in egg cells. Include all the major players beginning with the second messenger. Label all parts clearly so I can read your labels. If you have messy handwriting, print neatly or type. You can draw arrows to show the flow of information. You may want to use more than one color.

Your diagram needed to include IP_3, its receptor, in the ER, Calcium leaving, CICR, calcium interacting with the vesicle, and exocytosis.

8 pts.

5) List the major steps of the sodium/potassium pump and number this list. Then draw a picture showing these steps and label with numbers only. Start your list at the step where sodium has just been released from the pump. Be sure to quantify any critical components of this process.

Start with 3 Na^+ ions leaving pump

2 K^+ ions bind to high affinity sites

This causes the phosphate to come off

This causes the pump to flip

This causes the 2 K^+ ions to come off as pump loses its affinity for K^+ ions
This causes high affinity binding sites for 3 Na^+ ions
This causes an increased affinity for ATP
This leads to phosphorylation of the pump
This leads to the pump flipping and 3 Na^+ ions floating free (repeat cycle at step 1)

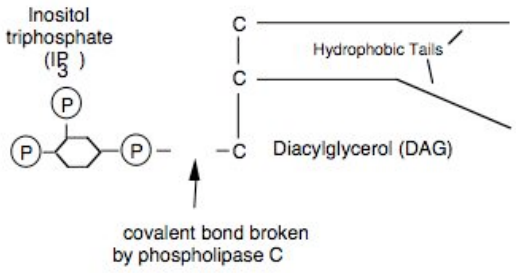
PLUS A PICTURE TO MATCH

6 pts.
6) Explain why a nerve terminus must perform as much endocytosis as exocytosis.
Exocytosis leads to new membrane being added to the plasma membrane. If the presynaptic membrane is going to stay in the synapse, it cannot continue to grow. Therefore, it must internalize about the same amount of membrane through endocytosis as was added to the PM via exocytosis.

10 pts.
7) a. In outline format, describe how phospholipase C is activated.
G protein that was activated by a sperm-egg receptor interaction

b. What is are the substrate and products for phospholipase C (full names are worth more points than abbreviations)?
Phosphytidyl inositol-bisphosphate (PIP_2) is the substrate which is cleaved into intositol triphosphate (IP_3) and diacylglycerol (DAG).
c. Draw a picture of the two products. Show as much chemical detail as you can.

Something similar to this:



6 pts.
8) Is it possible to predict whether an allosteric modulator will enhance or reduce an enzyme's activity? Explain your answer in 3 sentences or less.
No, you cannot predict whether a modulator will enhance or reduce an enzyme's activity. The effect of a modulator can only be determined experimentally.

8 pts.
9) a. As mentioned in the study guide, human vision utilizes cGMP. A certain biology student once hypothesized that consuming more caffeine would improve vision. Explain the basis for this hypothesis.
cGMP is similar in structure to cAMP (only the bases differ) and so the student may have thought that since caffeine blocks the destruction of cAMP by phosphodiesterase (PDE), it may have a similar effect on cGMP and thus improve vision.
b. Based on what we have studied so far, explain why caffeine does not affect vision.
Enzymes are specific, so the PDE that cleaves cAMP is probably different from the enzyme that cleaves cGMP. Therefore, caffeine may not have any affect on the cGMP-specific PDE.